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FORMATION OF BUSINESS SUSTAINABILITY OF THE TRANSPORT INDUSTRY IN THE CONTEXT OF INNOVATIVE TRANSFORMATIONS

Summary. The paper describes the peculiarities of the formation of business sustainability in the transport industry, and characterizes the main factors affecting it. It was determined that for the business sustainability of the transport industry, innovative processes and transformations play a significant role, which encourage enterprises to be client-oriented and provide quality service to consumers, the ability to adapt to changes in the economic situation and new social challenges. A feature of the modern development of the transport industry is the transition to an innovative path of development, which will allow transport enterprises to occupy more priority positions compared to their competitors. The impact of innovative transformations on ensuring business sustainability of the transport industry is characterized by the use of innovations in the implementation of commercial activities, ensuring the quality of services (products), which will make it competitive. The paper offers a methodical approach to choosing a strategy for managing the business sustainability of the transport industry in the conditions of innovative transformations, which allows choosing an appropriate development strategy depending on the indicators of economic activity (IEA), the level of business sustainability (IBS), risk indicators (IBR).

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1. INTRODUCTION

Integration processes and the development of modern innovative technologies significantly change the idea of enterprise management in modern conditions, prompting them to search for new business models, methods and processes, forming a modern view of enterprise management. In a rapidly changing economic situation, the ability of an enterprise to achieve business sustainability in the market is becoming the key to leadership. The level and dynamics of development of advanced (high) technologies, the mechanism of penetration of innovative transformations into global markets have become the defining characteristics of the new economic system. Innovative transformations differ from traditional forms of strategic change in that new technologies encourage companies to become customer-oriented and provide quality customer service, and to be able to adapt to changes in the economic situation and new social challenges.

A significant indicator of a country's technological progress is the level of development of its transportation system. Transport plays a fundamental role in the national economy as a component of production and social infrastructure. Transport appears to be an object of market relations, whose effective operation depends on the normal functioning and development of all sectors of the economy served by transport, enterprises, and their associations. It also affects the quality of life of the population. The transportation industry is characterized by intensive development. Globalization changes, the dynamic development of international trade and the rapid growth of the exchange of goods lead to a significant development of transport services [1]. The modern economy poses more and more challenges to the transport industry related to increasing transportation volumes, improving safety, improving the level of customer service, reducing costs, and increasing efficiency with the help of modern Industry 4.0 technologies. The usual methods of competition are no longer sufficient and no longer lead to the desired results, and therefore, the main competitive advantage is the ability to innovate. The innovative activities of transport companies should be aimed at improving the quality of services, increasing labour productivity, extending transportation distances, increasing market share, entering new markets, and at the same time forming business sustainability and reducing production costs. First of all, this can be achieved through the technical development of the industry and innovative transformations, which should be aimed at fully and efficiently meeting the existing transportation needs. Thus, innovative transformations have a significant impact on the formation of the business sustainability of the transport industry through the introduction of new technologies and management methods that must be efficient, safe, and reliable for society and the environment.

2. STATE OF THE ART FOR THE PROBLEM OF RESEARCH

The papers [2-6] discuss the theoretical, methodological, and practical aspects of developing transport infrastructure in order to improve the efficiency of the transport industry.

Papers [7, 8] consider the issues of financial and institutional development of the transport industry, as well as the peculiarities of investment support within the framework of the formation of transport corridors.

There is still an ongoing discussion about the key requirements for the modern innovative composition of transport infrastructure as part of the transport industry, which is studied in paper [9]. Researchers on the influence of factors and indicators for assessing the level of innovative development of transport infrastructure in general and individual components in particular are reflected in papers [10, 11].

According to paper [12], transportation infrastructure facilitates the coordination of economic activities among economic entities at the international, macro- and meso-levels, as well as at the level of economic sectors and enterprises.

According to the author [13], who points out that transport infrastructure is specific to each mode of production, therefore, in the analysis of economic systems, the following chain of infrastructure levels is distinguished: mega-system (world economy), macro-system (national economy), meso-system (regional economy, industry), micro-system (at the level of individual enterprises) and nano-system (economic activity of an individual).

We can agree with the opinion of the author [14] that transport infrastructure services are not only the most important consumer goods, but also a means of increasing productivity and improving access to markets, the state of infrastructure also directly affects the ability of the general population to enjoy the benefits of economic growth.

The issues of forming business sustainability of an enterprise are covered by the papers [15, 16] and others.

In the scientific paper [15], the business sustainability of an enterprise is defined as a system of various areas of enterprise management (business metrics) with a certain marketing complex. The author of the paper does not reduce the concept of “business sustainability” to synonymously simplified and identified concepts such as “financial sustainability” and “economic sustainability”, but proposes to consider business sustainability as a complex of three types of consistently related systems (organizational, market, economic systems).

In paper [17], business sustainability is considered as the concept of price, financial, economic, technological and organizational sustainability of an enterprise, which in general have different effects on it.

Given the scientific and practical significance of the publications of the aforementioned authors, it is imperative to emphasize that it is imperative to formulate theoretical and methodological foundations, methodological and practical recommendations for the establishment of the business sustainability of the transport industry, taking into account modern innovative transformations that incorporate advanced management technologies and contribute to the implementation of potentially effective tools for state regulation of innovation in the transport industry in terms of strategic, coordination and integration, and financial and investment directions of the state economic policy.

3. MATERIALS AND METHODS

Modern trends in the development of the transport industry are inextricably linked to the impact of digitalization of the economy and require the definition of new approaches to management. The transportation industry is a complex ecosystem that encompasses everything related to different modes of transportation, namely road, rail, sea, air, and pipeline transport. This industry includes the transportation of raw materials, finished goods as well as passengers. The growth of international trade has a great impact on the development of the transportation industry. It is the planning of all functions and sub-functions in the system of movement of goods and provision of services in order to minimize costs and maximize customer service that

constitutes the concept of business sustainability of the transport industry. The sustainability of the transport industry is characterized by its ability to support the mobility needs of society in a way that is least damaging to the environment and does not disrupt the mobility needs of future generations [18].

Sustainable development in relation to transportation systems requires developing and strengthening the links between environmental protection, economic efficiency and social progress.

In the environmental dimension, the goal is to understand the mutual influences of the physical environment and industry practices, and that environmental issues are addressed by all aspects of the transportation industry. In the economic dimension, the goal is to orient progress in the sense of economic efficiency. Transportation must be economical and able to adapt to changing demands. In the social dimension, the aim is to improve the standard of living and its quality [19].

The peculiarity of the modern development of the transport industry is the transition to an innovative way of development, which will allow transport enterprises to take a higher priority position compared to their competitors with a low level of innovation potential and make a qualitative leap to a new technological mode. The impact of innovative transformations on the business sustainability of the transport industry is characterized by the use of innovations in commercial activities and allows taking a leading position in the global market, and providing services (products) with a high degree of science intensity and novelty, thereby making them competitive.

There is a two-way relationship between innovation and sustainable development. On the one hand, economic, social and environmental factors improve as a result of intensified innovation. On the other hand, these changes lead to the accumulation of funds, knowledge, and skills to spread innovation processes in the country [20].

It should be noted that the formation of the business sustainability of the transport industry is proposed to be considered as a complex of five types of consistently related sustainability systems: economic, environmental, social, organizational, and financial. It should be noted that the essence of each type of functional sustainability has its own set of essential factors that require careful analysis and are directly influenced by innovative transformations.

Solving the problems of business sustainability is impossible without the use of innovative mechanisms in the management of the transport industry. The level of innovation potential has a huge impact on the formation of managerial and technological innovations, their application determines the efficiency of decision-making, increasing the effectiveness of management personnel in achieving business sustainability in the transport industry [21].

The impact of innovative transformations significantly changes the transport industry, affecting changes in strategy, business model, logistics process, marketing and other areas as a result of the use of innovative technologies. In this regard, the authors propose a system for the formation of the business sustainability of the transport industry in the context of innovative transformations (Fig. 1).

The development and integration of the transport network removes existing market barriers and facilitates the interaction between various electronic systems and technological standards to optimize processes and customer service. Long-term competitive advantages arise only when an enterprise continuously improves its innovative technologies and widely uses them [22].

Therefore, the priority areas in forming the business sustainability of the transport industry under the influence of innovative transformations are:

- introduction of sustainable customer-oriented business models aimed at achieving economic efficiency, taking into account environmental safety factors, mainly aimed at preserving natural resources and factors of social well-being – human capital development;
- increasing the share of “green” vehicles;
- selecting more environmentally friendly modes of transport (with lower CO₂ emissions) for multimodal transportation;
- improving delivery planning and route optimization;
- cooperation and effective interaction with partners.

To support the efficient functioning of the transportation industry, it is advisable to improve the efficiency of equipment operation and maintenance.

For this purpose, operational systems are used, which include the following components: the object of operation, processes, procedures, algorithms of maintenance, personnel, regulatory documents, resources, etc. [23].

A high level of business sustainability of the transport industry is achievable with the introduction and use of innovative technologies in the main types of transport, which improve the quality of service and provide convenient services to consumers without the need to create additional infrastructure. Among the main innovative technologies in transportation are: intelligent cargo and IoT (“Internet of Things”); technical improvement of vehicles; application of information and automated systems; blockchain technologies; smart storage; real-time tracking; intelligent delivery; implementation of Industry 4.0 technologies [24].

Thus, the implementation of the Industry 4.0 concept in the transportation industry is aimed at responding quickly to market competition, meeting customer needs, improving operational efficiency, and reducing overproduction, energy consumption and waste, thus moving towards a more sustainable development of the industry. The concept of Industry 4.0 can be applied to the business models of the transportation industry and their elements when creating value for the customer, as well as to the assessment of the product life cycle. This translates into the achievement of business sustainability goals, in terms of environmental sustainability — aimed at reducing the number of materials used, increasing the share of reused, recovered and recycled materials, as well as reducing the total amount of waste. From a social sustainability perspective, the concept of Industry 4.0 is related to the technological development of production and changes in working conditions, namely to the replacement of manual labour with automated labour.

Blockchain technologies are used to distribute data and improve security in supply chains and manufacturing processes. These characteristics can be used to track business sustainability-related metrics, such as resource provenance, and make them available to stakeholders and decision-makers.

IoT (“Internet of Things”) technology is changing the transportation industry dramatically, providing a huge amount of real-time data on how different vehicles operate and are used around the world. IoT can also be used to adjust schedules and provide personalized services on different modes of transport, help congested cities to encourage the use of public transport instead of private vehicles and reduce the load on the road network. Technology can reduce costs and speed up the implementation of services.

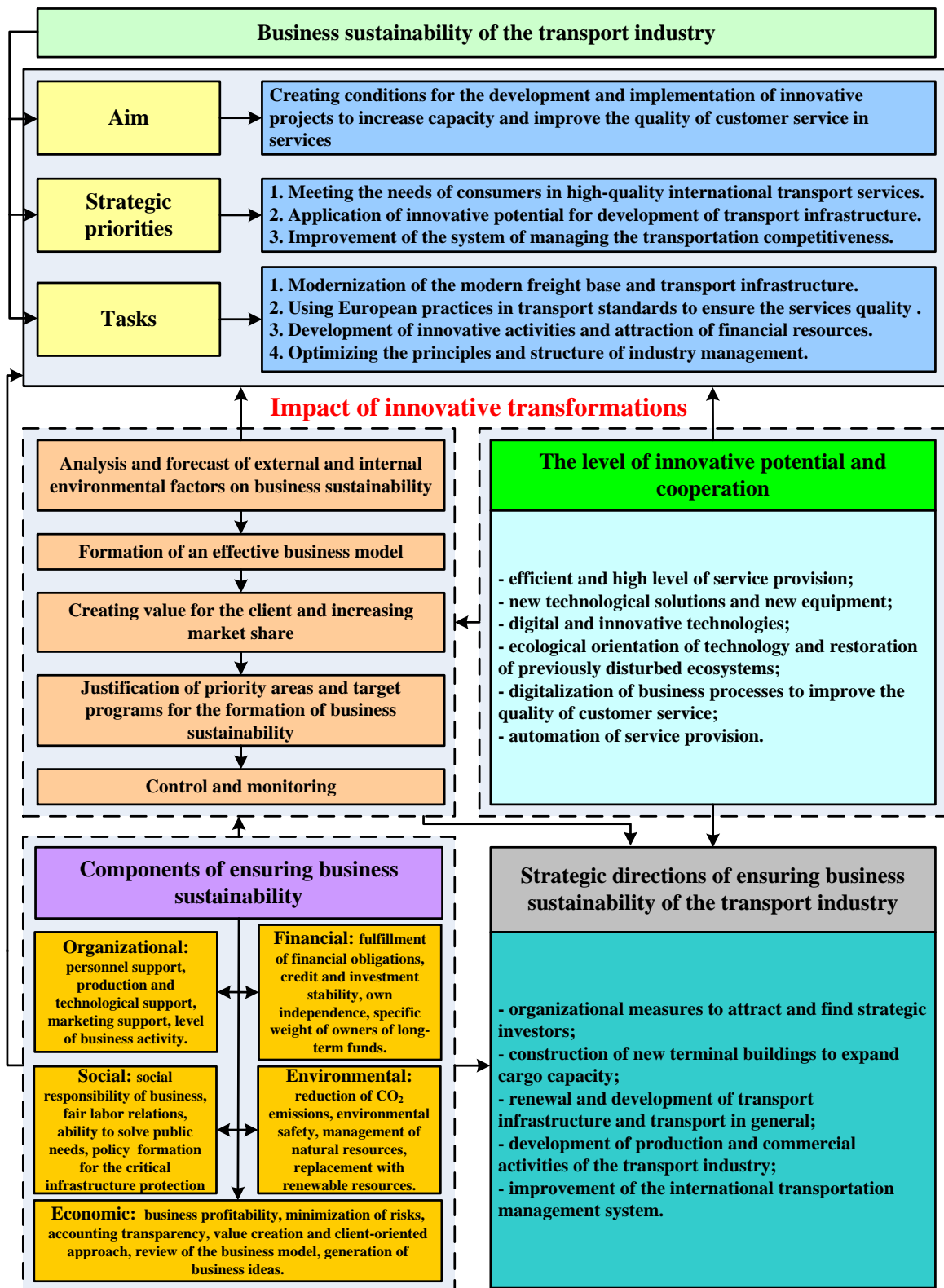


Fig. 1. System of formation business sustainability of the transport industry in the context of innovative transformations

The formation of the business sustainability of the transportation industry is proposed to be achieved in the following ways:

- effective cooperation, meeting the trends of Industry 4.0, optimization of management of integration of market participants in the conditions of innovative transformations;
- correspondence to the mutual interests of enterprises, customer, market, and society. In order for the transportation industry to become business sustainable, it is necessary to pay special attention to mutual interests and the common good without harming the interests of others, as well as forming environmental safety and social welfare;
- balancing the factors of economic sustainability, environmental safety and social well-being, profit-oriented and increasing the welfare of society in the conditions of innovative transformations [26].

4. RESULTS AND DISCUSSION

Business sustainability management in the context of innovative transformations in the transport industry can be carried out through the use of appropriate strategies. At the same time, it is necessary to take into account the main indicators of economic activity of enterprises in the industry, the integral indicator of business sustainability and the integral indicator of business risks [27, 28].

We propose the following methodological approach to choosing a strategy for managing the business sustainability of transport enterprises in the context of innovative transformations (Fig. 2).

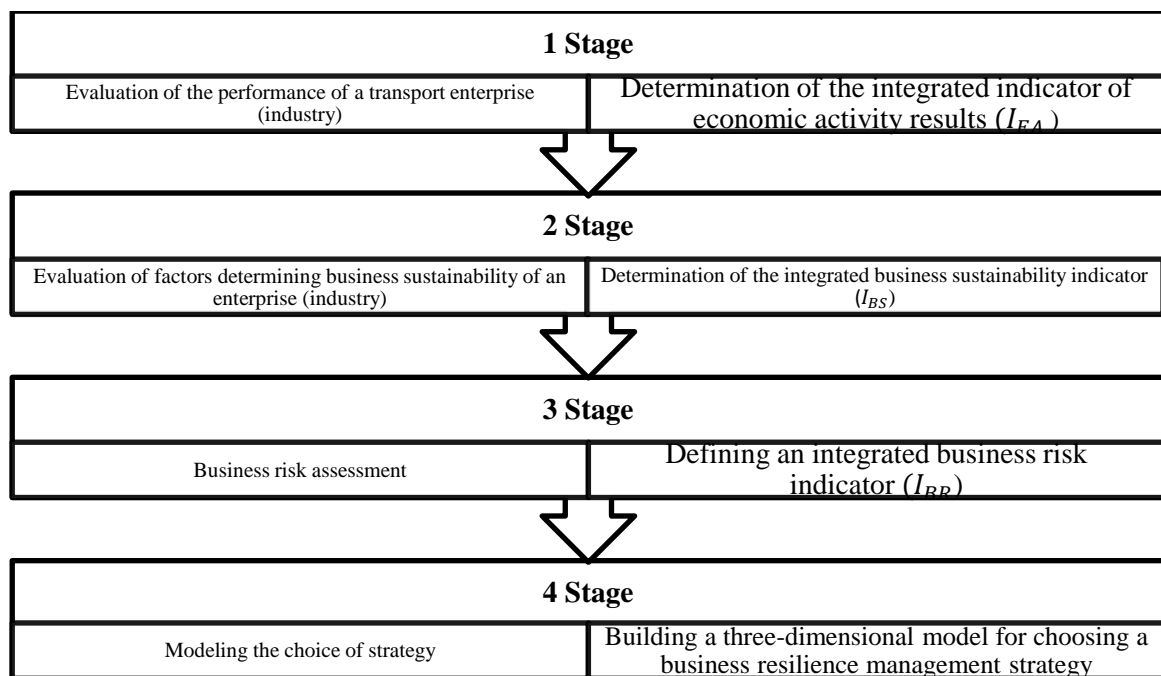


Fig. 2. Methodological approach to managing the business sustainability of the transport industry in the context of innovative transformations

Each of the stages of the proposed model is performed according to a specific algorithm.

Stage 1. Evaluation of the results of economic activity is carried out according to the following algorithm:

Step 1. Creating a hierarchical model of economic activity indicators that are factors in the formation of business sustainability. We propose to consider the following factors: x_1 - level of material and technical support; x_2 - financial stability; x_3 - level of innovation activity; x_4 - economic stability; x_5 - customer satisfaction index; x_6 - profit level; x_7 - investment volume; x_8 - transportation volumes.

Step 2. Expert assessment of the weighting coefficients of each factor. It is proposed to base the assessment on a survey of experts. Experts assess the priority of each factor on a 9-point comparative scale of relative importance by T. Saaty. Based on the expert assessments, a matrix of pairwise comparisons A is built, each element of which is defined as follows: $a_{ij}=k$, $k=2,3,\dots,9$, if the i -th factor is more important than the j -th, $a_{ij} = \frac{1}{k}$, $k = 2,3, \dots,9$, if the i -th factor is less important than the j -th, $a_{ij}=1$, if the i -th and j -th factors have the same priorities.

Step 3. Checking the consistency of the expert opinion. The following indicators are calculated based on the elements of the obtained matrix A :

- Generalized priority vector:

$$V = (v_1, v_2, \dots, v_n), \text{ where } v_k = \frac{1}{n} \cdot \frac{\sum_{j=1}^n a_{kj}}{\sum_{i=1}^n a_{ij}}. \quad (1)$$

- The coefficient μ , which is the convolution of three matrices:

$$\mu = E \cdot A \cdot V^T, \text{ где } E = (1, 1, \dots, 1)_{1 \times n}, \quad (2)$$

where:

V^T – is a column matrix transposed to V .

- Consistency Index:

$$CI = \frac{\mu - n}{n - 1}. \quad (3)$$

- The stochastic consistency index is calculated by the reliability level γ , which determines the probability that an expert opinion can be considered consistent:

$$RI = t_\gamma \cdot \frac{n-2}{n}, \quad (4)$$

where $t_\gamma = F^{-1}\left(\frac{\gamma}{2}\right)$ is the quantile of the normal distribution.

- Consistency ratio:

$$C_\gamma = \frac{CI}{RI} \quad (5)$$

determines the level of significance of the conclusion regarding the consistency of the expert opinion. That is, the expert opinion can be considered consistent with a probability of at least $1 - C_\gamma$.

Step 4. Evaluation of the integrated indicator of economic performance:

$$I_{EA} = \sum_{i=1}^n v_i \cdot x_i, \quad (6)$$

where x_i – are the actual values of i – th factor.

Stage 2. We propose to assess business sustainability using the following algorithm:

Step 1. Modelling the system of business resilience formation and creating a list of factors.

As noted above, the business sustainability system is considered as a complex of five related subsystems: s_1 - economic, s_2 - environmental, s_3 - social, s_4 - organizational, s_5 - financial. Each of the subsystems is determined by a number of factors. Therefore, the integrated indicator characterizing the activity of each subsystem can be defined as a function of a certain list of factors:

$$I_{S_i} = f_i(x_1^{(i)}, x_2^{(i)}, \dots, x_{k_i}^{(i)}), \quad i = 1, 2, 3, 4, 5. \quad (7)$$

To study the efficiency of transport systems, methods of increasing accuracy using segmented regression are usually used to determine the optimal frequency of operation processes, as well as to analyse possible routes and traffic intensity [29].

Step 2. Determination of the integrated indicators I_{S_i} characterizing each of the subsystems. It is proposed to estimate the values of integrated indicators using mathematical models of the following type:

$$I_{S_i} = \sum_{j=1}^{k_i} w_j x_j^{(i)}, \quad (8)$$

where w_j – are the weighting factors, $x_j^{(i)}$ are the actual values of the j -th indicator.

Step 3. Building a hierarchical model for calculating the integrated business sustainability indicator. This module can be built similarly to the previous stage, i.e. repeat steps 2 and 3 of the algorithm of stage 1 for business sustainability indicators. As a result of applying the method of pairwise comparisons, we will get a set of five weighting coefficients $((\lambda_i)_{i=1,5})$, that will determine the priority of considering the indicators of each of the five subsystems of business resilience formation.

Step 4. Assessment of the integrated business sustainability indicator:

$$I_{BS} = \sum_{i=1}^5 \lambda_i \cdot I_{S_i}, \quad (9)$$

where I_{S_i} , is the integrated indicator of the i -th subsystem.

Stage 3. Assessment of business risks:

Step 1. Determining the list of risk situations that may affect business sustainability. We will modulate risk situations as random events A_t , $t = 1, 2, \dots, N$. In the model, we consider the events to be independent.

Step 2. Determining the expected value of the probability of each of the risk situations $P_t = P(A_t)$. We propose to estimate this value using a statistical or expert method.

Step 3. Determination of the integrated business risk indicator as the probability of a risk-free situation:

$$I_{BR} = \prod_{t=1}^N (1 - P_t) \quad (10)$$

As a result, after the third stage of modelling, we get a set of three indicators (I_{EA} , I_{BR} , I_{BS}). Given the construction algorithms, all three integrated indicators have the following properties:

- their values are normalized, i.e., they belong to the interval [0,1];
- an increase (decrease) in the value of the integrated indicator means an improvement (deterioration) of the component being evaluated.

Stage 4. To select a program for the development and management of business resilience, a model based on a three-dimensional matrix can be used. On the axes of this matrix, we will determine the values of the indicators of economic performance, business sustainability and business risks (Fig. 3).

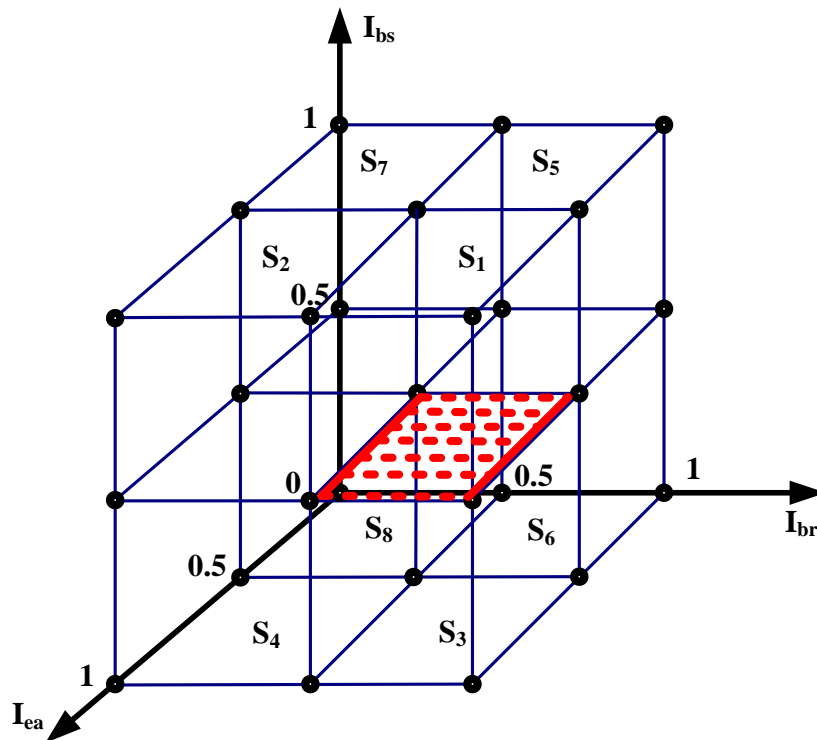


Fig. 3. Three-dimensional matrix model for choosing a strategy for the development and management of business sustainability in the transport industry

The range of values of each of the integrated indicators is divided by the median value into two areas. Thus, for sets of three values of the integrated indicators, we will have eight areas, each of which corresponds to a specific strategy (Table 1). Based on the comparative analysis of the main indicators of the enterprise's activity, it is proposed to consider eight strategies: four active strategies ($S_1 - S_4$) and four inertial strategies ($S_5 - S_8$).

Tab. 1

Ranges of values of integrated indicators for choosing a development and management strategy

	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	S ₈
I_{EA}	$\geq 0,5$	$\geq 0,5$	$\geq 0,5$	$\geq 0,5$	$\leq 0,5$	$\leq 0,5$	$\leq 0,5$	$\leq 0,5$
I_{BS}	$\geq 0,5$	$\geq 0,5$	$\leq 0,5$	$\leq 0,5$	$\geq 0,5$	$\leq 0,5$	$\geq 0,5$	$\leq 0,5$
I_{BR}	$\geq 0,5$	$\leq 0,5$	$\geq 0,5$	$\geq 0,5$	$\geq 0,5$	$\geq 0,5$	$\leq 0,5$	$\leq 0,5$

S_1 - an offensive development strategy that maximizes the use of the company's existing high potential. Active business development, keeping risks at a low level;

S_2 - stabilization strategy, risk mitigation, development of existing potential;

S_3 - strategy of continuing operations with the development of business activity;

S_4 - strategy of strengthening positions, development of business activities, risk management;

S_5 - strategy for restoring and developing economic performance indicators, maintaining business activity;

S_6 - survival strategy;

S_7 - reduction strategy;

S_8 - liquidation strategy.

Results of the application of the proposed methodology for assessing the performance of the transport industry of Ukraine in the year 2021 [30].

$I_{EA} = 0,71$, the value of the integrated indicator of economic activity is greater than the median value, which means that it is advisable to choose one of the active strategies for the development and management of business sustainability.

$I_{BS} = 0,67$, the value of the business sustainability indicator is also higher than the median value, which means that the management strategy should use the existing potential and provide for the retention and development of business activity.

$I_{BR} = 0,39$, the value of the integrated business risk indicator is less than the median value, which allows us to determine the optimal strategy S_2 as stabilization of the existing potential with an emphasis on reducing business risks.

The developed model can be used to determine the optimal strategy for the development and management of business sustainability of a transport industry enterprise. Its advantage is the consistent consideration of three complex indicators, which in turn include a number of factors characterizing various aspects of the enterprise or industry. These algorithms allow for determining and analysing the performance indicators of any enterprise and allow generalization to other industries and activities.

5. CONCLUSIONS

Solving the problems of creating business sustainability in the transport industry is impossible without the use of innovative mechanisms in enterprise management. The innovative activity of the transport industry should be aimed at improving the quality of services, increasing labour productivity, increasing the range of transportation, increasing market share, entering new markets, and at the same time ensuring business sustainability, and reducing production costs.

The business sustainability of the transport industry when implementing the strategy should consider the flexibility of management processes based on the use of innovations in modelling economic activities. In this case, it is important to establish the nature of the program being implemented, which, depending on the prevailing conditions, can be active or passive. Optimizing results will allow the management of transport enterprises to make more informed management decisions aimed at implementing development programs in the long term.

Thus, innovative transformations significantly affect the business sustainability of the transport industry through the introduction of new technologies and management methods, which must be efficient, safe, and reliable for society and the environment.

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